UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/746,064	12/26/2000	Mizuhisa Nihei	001701	1990

7590 06/20/2003

ARMSTRONG, WESTERMAN, HATTORI
McLELAND & NAUGHTON
Suite 1000
1725 K Street, N.W.
Washington, DC 20006

EXAMINER
BAUMEISTER, BRADLEY W

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 06/20/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/746,064	Applicant(s) Nihei et al.
	Examiner B. William Baumeister	Art Unit 2815

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *Apr 11, 2003* .

2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *3-8 and 10-14* is/are pending in the application.

4a) Of the above, claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *3-8 and 10-14* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some* c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). _____
4) ☐ Interview Summary (PTO-413) Paper No(s). _____
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Rejections - 35 U.S.C. § 103

2. Claims 3, 4 and 10-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicants Admitted Prior Art in view of Imaizumi et al. '717.

a. Applicant acknowledges that it was known to make metal gate MESFETs and HEMTs with S/D and G contacts that are composed of Ti/Pt/Au (see e.g., prior art FIG 1 and the BACKGROUND OF THE INVENTION portion of the specification). Applicant does not disclose that it was known to further provide metal oxides interposed between the metal gate and the channel.

b. Imaizumi discloses MESFETs having Schottky gate electrodes formed over III-V semiconductor layers with a thin metal oxide interposed therebetween. The oxides may be formed of various metals such as Ti, Co or Ni. Further, while Imaizumi provides express examples of InP based semiconductors, the teachings are not so limited. Rather, the reference expressly states that the invention may be employed in other III-V semiconductor systems (col. 6, lines 1-3). It would have been obvious to one of ordinary skill in the art at the time of the invention to have employed a metal oxide as taught by Imaizumi at the metal gate/semiconductor interface of the prior-art

MESFET or HEMT for the purpose of reducing the leakage current and increasing the breakdown voltage as taught by Imaizumi (e.g., ABSTRACT).

c. Regarding claims 3 and 4, regardless of whether Imaizumi expressly recites whether the oxide is stoichiometric or not, it was well known to those of ordinary skill in the art at the time of the invention that whether the oxide's composition is stoichiometric depends on the oxidation times and conditions, and no unexpected results would result from using one vs the other.

d. Newly added claim 14 sets forth that the intermediate (TiO2) layer has a thickness of about 4 nm (or 40 angstroms). Imaizumi further discloses that the oxide thickness must be limited to less than 10 monolayers (e.g., col. 2, line 15 and line 56; and col. 4, line 7 and line 37). Note Teraguchi '514 which provides evidence of the fact that the lattice constant of TiO2 is 4.593 angstroms (see col. 5, Table 3). As such, Imaizumi's disclosure of an oxide thickness that is less than 10 monolayers can be restated as saying that the oxide thickness must be less than about 4.593 nm, which reads on the thickness set forth in claim 14. It would have been obvious to one of ordinary skill in the art at the time of the invention to have formed the oxide to a thickness that is less than 4.6 nm (or "about 4 nm") for the purpose of preventing the formation of dangling bonds, and thereby allow a Schottky electrode with a sufficiently high barrier height to obtained, as taught by Imaizumi (e.g., col. 2, lines 40-).

3. Claims 5-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art--Imaizumi et al. '717 as applied to the claims above and further in view of Kirchner et al. '450 (previously made of record). Imaizumi teaches that the oxide may be interposed between the gate and the semiconductor, but does not further teach that it may be employed over other regions of the surface.

a. Kirchner discloses FETs having a tunneling oxide insulating layer interposed between the gate and channel. Further, various embodiments depict that the oxide may be formed under the S/D regions (FIG 9) and may cover the entire surface (FIG 10). It would have been obvious to one of ordinary skill in the art at the time of the invention to have further employed the tunnel metal oxide as taught by Applicant's Admitted Prior Art--Imaizumi under the S/D regions as taught by Kirchner for the purpose of preventing metal from diffusing therefrom into the semiconductor. It would have been further obvious to coat the entire surface for the purpose of simplifying the masking design.

Response to Arguments

4. Applicant's arguments filed 11/5/2002 have been fully considered but are not persuasive.

a. Applicant has argued that the cited art does not teach or suggest--either alone or in combination--the intermediate layer including TiO2 formed between the Ti layer and the compound semiconductor layer. This is not persuasive because as was explained previously and hereinabove, Imaizumi does teach the inclusion of such a TiOx layer in the manner claimed.

b. Applicant has argued that the Examiner's motivation for combining Imaizumi's teachings--relating to the inclusion of the TiOx layer--are incorrect. Specifically, Applicant urges that (1) the Examiner's assertion that the motivation, "for the purpose or reducing the leakage current and increasing the breakdown voltage as taught by Imaizumi" is incorrect; but rather (2) that "[u]pon a careful re-review of Imaizumi, it is noted that the metal oxide layer of Imaizumi is provided for suppressing formation of dangling bonds caused by stress." (REMARKS, pages 2-3) This argument is not persuasive for the following reasons:

i. As an initial matter, the Examiner notes for the record that Imaizumi's statement commencing at col. 2, line 40 -- "Since a metal oxide layer can be interposed between the semiconductor substrate and the Schottky electrode with the thickness of not more than 1 monolayers [sic] by the above mentioned method, the generation of dangling bonds due to the elastic strain between the substrate and the metal oxide layer is prevented, ..." -- contains a typographical error. Specifically, the fact that the recitation, "less than 1 monolayers," is a typographical error is evident on its face since "monolayers" is set forth in the plural instead of the singular. More importantly, all of the other portions of the reference's disclosure addressing the metal oxide thickness state that the thickness must be limited to less than 10 monolayers--not less than 1 monolayer (e.g., col. 2, line 15 and line 56; and col. 4, line 7 and line 37). As such, when the reference is read as a whole it is clear that, not only is the lone recitation of "less than 1 monolayer" a typographical error, but also that "less than 10 monolayers" was actually intended.

ii. Further, upon a careful re-review of Imaizumi, it is noted that this same passage cited by Applicant (relating to maintaining the thickness to less than 10 monolayers to prevent dangling bonds) goes on to state "...[thereby] allowing a Schottky electrode with a sufficiently high barrier height to be obtained and therefore to obtaining MESFETs and Schottky electrodes whose reverse bias current is small and break-down voltage is large. In the case of metal oxide layer with the thickness of more than 10 monolayers, the elastic limit is surpassed and defect levels due to dangling bonds at the interface are formed because of the stress at the interface." (Col. 2, lines 40-54; underline added). Accordingly, the Examiner's motivation for combining Imaizumi was--and is--proper.

c. The Examiner maintains the following position previously set forth in the last Office Action:

> In response to applicant's argument that Imaizumi addresses the issues of increasing the gate breakdown voltage and minimizing reverse leakage current by increasing the Schottky barrier height of the gate electrode, but that there is no suggestion at all to suppress the threshold voltage change caused by diffusion of Ti atoms (REMARKS page 5), the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

In response to this position, Applicant has now argued (1) that the advantages of the claimed invention do not flow naturally from the teachings or suggestions of Imaizumi; and that (2) the Examiner's rejection constitutes impermissible hindsight.

i. First, the Examiner notes that Applicant has not provided any factual evidence to support the conclusory argument that the advantages of the claimed invention do not flow naturally from the teachings or suggestions of Imaizumi when combined with Applicant's prior art admissions.

ii. Second, in response to applicant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

d. The arguments relating to newly added claim 14 have been addressed above.

e. For the above reasons, the rejections are still deemed to be proper and are therefore maintained.

Conclusion

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

INFORMATION ON HOW TO CONTACT THE USPTO

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister,** at **(703) 306-9165.** The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

B. William Baumeister

Patent Examiner, Art Unit 2815

June 16, 2003

EDDIE LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800